

**REMARKS**

Claims 1, 3-12, 16-30 and 32-39 are active in the case. Reconsideration is respectfully requested.

**Claim Amendments**

Claim 25 has been amended by deleting the superfluous word "then." Entry of the amendment is respectfully requested.

**Claim Rejection, 35 USC 112, First Paragraph**

Claims 1 and 9 have been amended to correct and clarify each claim as to the matter of the dissolution of iron from manganese ore. Thus, Claim 1 has been amended to recite that iron, not manganese, has a degree of dissolution of 70 % by wt or higher, thereby maintaining consistency of language in the claim. Further, Claim 9 has been amended to recite iron dissolution of at least 70 % by weight based on the iron (not manganese) content of the manganese dioxide ore.

**Invention**

As stated in Claim 1, the invention is directed to a treated manganese dioxide ore that is useful for producing manganese sulfate. The treated ore of the invention has a degree of manganese dissolution of 98.0 % by weight or higher based on the manganese contained in the treated manganese dioxide ore when dissolved in sulfuric acid and having a degree of iron dissolution of 70 % by weight or higher based on the iron contained in the treated manganese

dioxide ore when dissolved in sulfuric acid.

The present invention relates to a treated manganese ore from which manganese sulfate is derived by which electrolytic grade manganese dioxide is prepared. The treated manganese ore is of exceptional purity, as stated in Claim 1, having a degree of manganese dissolution of 98.0 % or higher based on the manganese content of the treated ore. The process by which the treated ore of the invention has the advantages of reducing the amount of slag in the production step and also reduces the potassium content of the ore which is important in preparing a product which can be used to prepare manganese dioxide of high purity for use in electrolytic applications.

Claim 7 is directed to the aspect of the invention by which the treated manganese ore of the invention is prepared by subjecting an appropriate manganese ore to reduction by contact with at least one reducing gas of methane, carbon monoxide and hydrogen in combination with a diluent of an inert gas. The amount of the reducing gas used ranges from 1.0 to 2.0 times the theoretical amount necessary to reduce the manganese ore.

Another embodiment of the process is that following the reduction treatment of the ore, the reduced ore is immersed in water having a temperature of 70° C to the boiling point at atmospheric pressure as embodied in Claim 10.

#### Prior Art Rejection

Claims 1, 3, 4, 6, 7-9, 16-21, 35 and 36 stand rejected based on 35 USC 103(a) as obvious over Yagihashi et al. This ground of rejection is respectfully traversed.

Claims 1-9 and 16-22 stand rejected based on 35 USC 103(a) as obvious over Welsh, U.

S. Patent 3,375,097. This ground of rejection is respectfully traversed.

As stated previously with respect to Yagihashi et al, the reference discloses the reduction of manganese ore with a reducing gas at a temperature of 700° C. However, Figure 6 on page 18 (1062) of the reference discloses that after MnO<sub>2</sub> has been reduced to MnO, when air is blown over the MnO after it has been cooled to room temperature, the MnO oxidizes again. That is, it reoxidizes. Upon reoxidation, it is believed Mn<sub>3</sub>O<sub>4</sub> is produced which can be indicated as the combination: MnO<sub>2</sub>·2MnO. Because the MnO<sub>2</sub> component of the combination is insoluble in acid, the degree of manganese dissolution in an acid is diminished. Thus, the degree of reoxidation resistance is an important factor in determining the degree of dissolution of treated (reduced) manganese ore in an acid. From Fig 6 of the reference, a reoxidation ratio can be read therefrom. (The reoxidation ratio can be determined from the expression: (maximum reduction in weight-(reduction in weight after introduction of air))/maximum reduction in weight x 100. .) The percentage reduction from the graphs of Figure 6 can be estimated to be 3.8 %. This means that with respect to the reduced ore obtained by the means described in Yagihashi et al, the degree of dissolution of the reduced ore in acid is 100-3.8 or 96.2 %. This degree of manganese dissolution is not satisfactory and does not meet the degree of manganese dissolution of the present claims.

In the work leading to the present invention, applicants have taken particular note of Fe in the manganese ore. A key aspect of the present invention is that applicants have succeeded in reducing the Fe in the ore to metallic Fe, as well as reducing manganese oxide. It has been found that the metallic iron that is produced functions as an antioxidant to MnO. In the present process, because the reoxidation of MnO is prevented by the metallic Fe, That is, in the event

the MnO is exposed to oxygen in the air, the metallic Fe prevents reoxidation of the MnO. This prevention or suppression of reoxidation is also exhibited when the MnO is subjected to the oxygen that is present in aqueous solutions when the MnO is leached and dissolved into solution.

According to the present invention, the degree of dissolution in acid of manganese is 98 % by weight or higher.

Applicants again stress with respect to Yagihashi et al that the method disclosed therein for the handling of the presence of iron in the processing described is quite different from the manner in which the presence of iron is handled in the present invention. That is, Yagihashi et al describes on page 1063, left column, lines 18 to 23 that the reduced iron that is formed at low temperature is a cause of the carbon deposition that is noted when carbon monoxide is used as the reducing gas. On page 1064, right column, lines 3 to 16 the reference states that because the occurrence of the deposition of carbon is undesirable for various reasons, conditions must be selected to avoid the carbon deposition, and these include the type of ore selected, the high temperature chosen for reduction and the use of a low CO concentration. Clearly, Yagihashi et al views the presence of Fe as something that does more harm than good. Further, Yagihashi et al sets the conditions by which no Fe is formed. That is, in order to improve the oxidation resistance of the MnO that is prepared, Yagihashi et al employ the technique of increasing the crystallinity of the MnO product. This objective is quite different from the means by which oxidation resistance is achieved in the present invention.

Claims 1, 3-9, 16-22, 35 and 36 stand rejected based on 35 USC 103(a) as obvious over Welsh '097. This ground of rejection is respectfully traversed.

As previously stated in the record regarding Welsh, the form in which iron is present in the ore of the reference is  $Fe_2O_3$  as described at column 14, line 50. The  $Fe_2O_3$  is **not** reduced to Fe under the conditions stated in the patent in which the ore is subjected to methane gas, hydrogen and an inert gas process of the reference at a temperature ranging from 538 to 593° C. This stands in contradistinction to the present invention where in the treated ore, the iron oxide is reduced to iron. Subsequently, upon exposure of the treated ore to air, oxidation of Fe preferentially to  $Fe_2O_3$  occurs before the oxidation of Mn. Thus, the oxidation of Mn to  $Mn_3O_4$  is prevented which in turn means that the degree of Mn dissolution in sulfuric acid is increased. This aspect of the present invention can not therefore be expected in the process of the reference. Rather, upon exposure of the treated ore of the reference to air, oxygen combines with Mn and it is reoxidized to  $Mn_3O_4$  which means that the extent of manganese dissolution in sulfuric acid decreases. It is clear that the reference does not show or suggest the effect of the iron produced by reduction of the ore provides for a treated ore that exhibits a higher degree of manganese dissolution as in the present invention.

Applicants point out that when the ore of Welsh is reduced under the conditions disclosed therein of methane gas, hydrogen or CO and an inert gas at a temperature of 538 to 593° C,  $Fe_2O_3$  is not reduced to Fe as can be verified by the Fig. 1 of page 134 of the enclosed Matoba et al document which shows the oxidation-reduction equilibrium diagram of iron.

Note the reducing gas disclosed in column 3, lines 55-60 of the patent. Since CO and  $H_2$  are both reducing components and because both  $CO_2$  and  $N_2$  are inert gas components, the sum of reducing gases is 37 % while the sum of inert gases is 63 %. As shown in the diagram of Fig 1, at 63 % of inert gas (63 %  $CO_2$ ), although  $Fe_2O_3$  in region (III) can reduce to  $FeO$  in region

(II), at a temperature in the vicinity of 680° C, FeO does not clearly reduce to Fe in region (I) even at temperatures greater than 680° C.

It should be noted also that the reducing ability of H<sub>2</sub> is different from that of CO with the reducing ability of H<sub>2</sub> generally greater than that of CO. Because of the greater reducing capability of H<sub>2</sub> than CO, hydrogen will more readily reduce something that is more easily reduced. In the case of the system of Welsh, because MnO<sub>2</sub> is more easily reduced than Fe<sub>2</sub>O<sub>3</sub>, the relatively small amount of H<sub>2</sub> gas in the gas composition of the reference is consumed in the reduction of MnO<sub>2</sub>. Thus, under the circumstances of Welsh, Fe<sub>2</sub>O<sub>3</sub> is not reduced to Fe by the CO in the mixed gas. The rejection of the claims over Welsh is believed and withdrawal of the rejection is respectfully requested.

Claims 1, 3-6 10-12, 23, 25-30, 37 and 38 stand rejected based on 35 USC 103(a) as obvious over El Tawil, U. S. Patent 4,985,216. This ground of rejection is respectfully traversed.

As stated on the record previously, the El Tawil patent discloses a process for treating a Mn-Ag ore for the recovery of silver values from the ore. (See, for example, Claim 1 and column 5, lines 40-42.) Although there is a description at column 4, lines 55 to 57 that the Mn-Ag ore contains silica, lead, zinc and copper in addition to Mn and Ag, there is no description that the ore contains Fe. Accordingly, there could not be and there is **no** description of the key feature of the present invention of the effect which the presence of Fe has in the treated Mn ore of the invention, which is that Fe prevents the oxidation of Mn to Mn<sub>3</sub>O<sub>4</sub>, thereby increasing the extent at which Mn dissolves in sulfuric acid. Nor does it describe an expression from which such an effect can be expected. Thus, the treated ore of El Tawil is not that of the present invention.

There is also no description in the reference of the subject matter of present Claim 3 which is that the amount of potassium soluble in sulfuric acid to that of Mn present in the treated Mn ore is 0.001 part by weight or less.

Present Claim 4 requires the reduction of manganese ore with a reducing gas at a temperature ranging from 400 to 790° C. However, the reference at column 2, lines 11-20 discloses the reduction of ore at 700-900° C with hydrogen or natural gas. Thus, the reference would not appear to meet the conditions of Claim 4.

The Examiner notes that the reference discloses the cooling of the reduced Mn ore in a non-oxidizing atmosphere as set forth in present Claim 7 and that the reduced manganese ore is cooled in a non-oxidizing atmosphere or in an aqueous bath at a temperature less than 100° C (Page 4, lines 7-11 of the Office Action) However, El Tawil in columns 2 and 4 and the claims describes that the ore is cooled to a temperature less than 100° C under non-oxidizing conditions after reduction, but does not describe the cooling in an aqueous bath. Clearly, the claims of the present invention are not obvious over the cited patent reference.

Claims 32-34 stand rejected based on 35 USC 103(a) as obvious over El Tawil, U. S. Patent 4,985,216, Welsh U. S. Patent 3,375,097 or Yagihashi et al, as applied above, further in view of Bowerman et al, U.S. Patent 4,489,043, and also Takehara, U. S. Patent 5,746,902, Andersen et al, U.S. Patent 6,214,198, Andersen et al, U.S. Patent 4,948,484 or Riggs, U.S. Patent 4,477,320. This ground of rejection is respectfully traversed.

It is known that the prior art that a reduced manganese ore is dissolved in sulfuric acid and that manganese dioxide is produced from an aqueous solution of manganese sulfate by electrolysis. However, the distinction of the present invention is that it is the treated manganese

dioxide ore of the present claims that is dissolved in sulfuric acid and then the dissolved manganese dioxide is subjected to electrolysis to form manganese sulfate. As set forth in the arguments above, applicants submit that the treated manganese dioxide ore of the invention is not shown or suggested by the cited and applied prior art, particularly El Tawil, Welsh and Yagihashi et al Accordingly, what applicants believe to be the patentable distinction of Claims 32-34 is the treated manganese ore of the invention as claimed, which treated ore provides the distinctiveness of the method aspects of the invention. Accordingly, withdrawal of the stated ground of rejection is respectfully requested.

Claim 34 stands rejected based on 35 USC 103(a) as obvious over Takehara, U. S. Patent 5,746,902 or Andersen et al, U.S. Patent 6,214,198, Andersen et al, U.S. Patent 4,948,484 or Riggs, U.S. Patent 4,477,320. This ground of rejection is respectfully traversed.

With respect to Claim 34, the claimed electrolytic manganese dioxide is, in fact, dependent on the reduced ore or reduced treated ore of Claim 1 or 5. This product has a very high degree of sulfuric acid dissolution of 98 % by wt or higher and even 99 % by wt or higher. Accordingly, when a manganese dioxide prepared by the process of the invention is employed in the process steps of Claim 34, the amount of slag which is generated can be reduced by a factor of 1/3 to 1/4 which reduces the load on the environment and reduces the concentration of potassium impurity in the electrolytic product manganese dioxide. This fact is shown in Table 1 of the specification where 6 examples within the scope of the invention of treated manganese ore have much lower potassium contents than the treated ores of Comp. Exs. 2 and 3, which examples do not conform to the limitations of the present process claims. On the other hand, none of the cited and applied patents teach the treated manganese oxide material of the present

claims as described above and therefore they could not possibly and do not suggest the claimed electrolytic grade manganese dioxide of present Claim 34.

While it is true that it is generally known that a reduced manganese dioxide ore can be dissolved in sulfuric acid and that a manganese dioxide is produced from an aqueous solution of manganese sulfate by electrolysis, what, of course, is distinctive of the present process is that treated manganese dioxide ore of the invention, which is not known in the prior art. Accordingly, the present invention is believed to be distinct over the art and withdrawal of the rejection is respectfully requested.

Applicants contest the Examiner's assertion as stated at the bottom of page 7 of the Office Action that the Welsh and Yagihashi et al references disclose the instantly claimed process of making the present treated manganese dioxide ore. The references do **no** such thing, because neither reference teaches or suggests a treated manganese dioxide ore **that has a manganese dissolution degree of 98 % by wt or higher.**

Appln. No. 09/824,768  
Reply to Office Action of September 16, 2003

Applicants remain of the opinion that the application is in proper condition for allowance.  
Early notice to this effect is earnestly solicited.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,  
MAIER & NEUSTADT, P.C.



Norman F. Oblon  
Attorney of Record  
Registration No.: 24,618

Frederick D. Vastine, Ph.D.  
Registration No.: 27,013

Customer Number

22850

TEL: 703-413-3000  
FAX: 703-413-2220